depression, but its presence undoubtedly had much to do with the existence and southward advance of the great area of high pressure that prevailed over the United States from the 20th to the end of the month. On the 28th, p. m., the low pressure of the northwestern coast of Mexico, which I have called No. XIII, had reappeared and the map had resumed an appearance very similar to that of February 21 and 22.

XIV.—On the 21st pressure fell in Saskatchewan, Manitoba, and Ontario, and an area of low pressure, No. XIV, was evidently passing southeastward at some distance to the north of our telegraphic reports. On the 23d, p. m., it was central in lower Canada, and 23d, a. m., near the mouth of the Saint Lawrence, after which it passed southeastward apparently over Newfoundland.

Cautionary storm signals for northwest winds on the New England coast were displayed on the 23d, a. m.

XV.—This storm center began on the 23d as a slight depression in the Gulf of Mexico, in the region between the cold northerly winds and rain of the Gulf States and the warm easterly winds and clear weather of the Florida Peninsula. In all this region the barometer was at this time still above the normal, but it fell during the 24th and 25th, while rain and snow were falling in the south Atlantic and Gulf States. On the 25th, a. m., the center of the cyclonic whirl was in northwestern Florida, but by the 25th, p. m., it was near Cape Hatteras, N. C.; after this the center of the whirl moved to the north-northwest, passing over Washington on the 26th, a. m., after which it turned more abruptly eastward, and at 8 p. m. was east of Nantucket, Mass.

Information signals were displayed on the 23d at all Gulf coast and south Atlantic stations; on the 24th northeast storm signals on the south Atlantic coast and information signals on the middle and east Atlantic; on the 25th, northeast storm signals on the middle and east Atlantic coasts. In connection with the development of this storm on the 25th and 26th, the following special dispatch was sent, on the 25th, 11 a. m., to stations in the middle Atlantic States:

Snow will extend over the middle Atlantic States and upper Ohio Valley by Monday morning, with indications that snowfall will be heavy and may interfere with railroad travel. Give this information to all railroad officials and report by letter the distribution made of this dispatch.

On the 25th, 10.30 p. m., the following dispatch was sent to Boston:

Notify railroads in southern New England that heavy snow Monday will probably interfere with travel.

XVI.—An area of relatively low pressure prevailed over Alberta and to the westward from the 23d to the 26th, during which period the barometer fell slowly over the Rocky Mountain plateau and northward. On the 26th pressure recovered in British Columbia and Alberta, and the lowest pressure passed southeastward into Manitoba, where it was central the 26th, p. m. On the 27th the center passed eastward over Lake Superior, and on the 28th apparently filled up and disappeared in Ontario and Quebec.

XVII.—On the 27th, a. m., an area of low pressure appeared moving southeastward into Alberta, and on the 28th, p. m., it was apparently central in Manitoba.

MOVEMENTS OF CENTERS OF AREAS OF HIGH AND LOW PRESSURE.

The following table shows the date and location of the beginning and ending of each center of high or low pressure that has appeared on the U. S. Weather Maps during the month, together with the average daily and hourly velocities for the month. These averages will differ accordingly as we consider each path as a distinct unit, or give equal weight to each hour of observation.

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
High areas.		°	°		°	°	*Miles.*	*Days.*	*Miles.*	*Miles.*
I	1, a. m.	46	118	7, p. m.	34	121	1,200	6.5	184	8
II	1, a. m.	39	98	2, a. m.	37	78	1,100	1.0	1,100	46
III	4, a. m.	33	101	7, a. m.	33	81	1,300	3.0	433	18
IV	8, p. m.	55	114	12, p. m.	50	65	2,400	4.0	600	25
V	8, p. m.	47	80	9, p. m.	48	65	800	1.0	800	33
VI	12, p. m.	41	113	17, a. m.	35	74	2,800	4.5	622	26
VII	17, a. m.	54	116	28, p. m.	40	110	1,300	11.5	113	5
VIII	23, a. m.	50	90	25, a. m.	41	73	1,200	2.0	600	25
IX	25, a. m.	31	99	27, p. m.	37	73	1,900	2.5	760	32
Sums							14,000	36.0	5,212	
Mean of 9 paths									579	25.2
Mean of 36.0 days									389	16.2
Low areas.										
I	1, a. m.	54	113	3, a. m.	50	70	2,000	2.0	1,000	42
II	3, a. m.	33	95	4, p. m.	39	70	1,700	1.5	1,130	48
III	7, p. m.	50	109	8, p. m.	52	98	500	1.0	500	21
IV	7, p. m.	47	86	8, p. m.	47	64	1,100	1.0	1,100	46
V	7, p. m.	30	99	11, a. m.	45	59	3,000	3.5	857	36
VI	8, a. m.	48	124	13, a. m.	41	70	3,900	5.0	780	32
VII	12, a. m.	31	114	16, a. m.	47	59	3,800	4.0	950	40
VIII	13, a. m.	49	127	18, p. m.	48	64	3,000	5.5	546	23
IX	17, p. m.	45	104	19, p. m.	34	86	1,300	2.0	650	27
X	17, p. m.	44	125	22, a. m.	33	75	3,700	4.5	822	34
XI	18, p. m.	46	88	19, p. m.	39	70	800	1.0	800	33
XII	19, p. m.	50	66	20, a. m.	47	60				
XIII										
XIV	21, a. m.	49	101	23, a. m.	50	62	1,800	1.0	1,800	75
XV	23, p. m.	28	87	26, p. m.	42	68	1,800	3.0	600	25
XVI	25, p. m.	53	115	27, p. m.	48	83	1,500	2.0	750	31
XVII	27, a. m.	55	115	28, p. m.	53	99	600	1.5	400	17
Sums							30,500	38.5	12,685	
Mean of 15 paths									846	35.3
Mean of 40.5 days									792	31.4

NORTH ATLANTIC METEOROLOGY.

[*Pressure in inches and millimeters; wind-force by Beaufort scale.*]

The normal barometric pressure for February over the North Atlantic Ocean, as deduced from the international simultaneous observations, is highest, 30.20 (767), in a small region between N. 26°, N. 31°, W. 34°, and W. 40°, but pressure is very uniform from the northern coast of Africa westward to the Mississippi Valley. The region of lowest pressure, 29.50 (749), includes Iceland, the southeastern coast of Greenland, and the islands of Spitzbergen. The isotherm of 30° F. passes from New Jersey northeastward, south of Newfoundland and Iceland, to northern Norway and thence southward between Norway and Sweden. The tracks pursued by storm centers, the frequency and velocity of storms are very nearly the same as for January; the average speed is 37 miles per hour for the United States and 23 for the North Atlantic Ocean. The number of storm centers that have been traced entirely across this continent and the Atlantic Ocean averages scarcely *two* in February, but the number for the current month seems to be rather above the average.

As compared with January the normal pressure for February is about the same in the eastern portion of the Atlantic, but falls 0.05 over the United States and the western portion of the Atlantic and 0.10 in the region between N. 50°, N. 60°, W. 10°, and W. 35°. In general, all cyclonic whirls on the Atlantic during this month that develop into severe storms are formed at the southwestern end of large and shallow depressions where the colder and denser air driven southward by terrestrial gravitation and rotation combines with other

influences, such as the buoyancy of the warm southerly winds and the clouds, to form the cyclonic whirl. When several such whirls have been formed within a general depression one of them, usually the southern one, is most favorably situated for further special development.

The weather phenomena, and especially the movements of areas of high and low pressure over the United States, begin to assume the appearance of an orderly system only when we study the daily charts for the whole Northern Hemisphere. By tracing the isobars from day to day, as we are able to do roughly over the North Pacific, North America, the North Atlantic, and northern Europe, or about one-quarter of the whole Northern Hemisphere, and bearing in mind the normal distribution of pressure over the rest of the hemisphere, it becomes evident that what is called the general circulation of the atmosphere consists, not of a slow average motion of the air, but of a system of rapidly alternating areas of low and high pressure, with corresponding cyclonic ascending and anticyclonic descending winds. The colder air in the areas of high pressure descends by gravity and is pushed southward by centrifugal force over the rotating earth; the lighter air of the anticyclones ascends by its buoyancy, viz, a deficiency of gravity, and is pushed northward by reason of its deficient centrifugal force, which latter action is supplemented by the precipitation of its vapor, the evolution of latent heat, and the added heat due to the action of the sun on the clouds. The presence of the American and the Asiatic continents modifies this circulation in such a manner that high areas, and also low, when once they have accumulated over the Rocky Mountains, move southeastward for a time, but when they have reached the Atlantic Ocean they have generally acquired a movement toward the east or northeast, and the lower portion of the air in the high area finally moves gently over the Atlantic Ocean and Caribbean Sea. The monthly and annual average pressures, temperatures, and winds, on which mathematical hydrodynamic studies are often based, have very little resemblance to the actual or normal daily map. The maps of the "International Bulletin of Simultaneous Observations" still offer a field for hydrodynamic studies.

In addition to the storms of the North Atlantic, some accounts have been received of typhoons in Madagascar and the Indian Ocean February 4, and off the coast of Japan February 21–23. The importance of obtaining fuller information of atmospheric conditions over the ocean west of our Pacific coast gives value to the following letter from Mr. Curtis J. Lyons, Meteorologist to the Government Survey, Honolulu, Sandwich Islands, under date of March 2:

The month of February has been remarkable throughout the entire Hawaiian group for electric phenomena, there having been eight distinct thunderstorms during this month at Honolulu, and nearly all unusually heavy for this region.

The views which I expressed on the *modus operandi*, direction, etc., of these storms in my paper for the Chicago Congress have received strong confirmation, viz, that while one essential element is the convectional, pillar-like rising of moist warm air in calm, the other essential element is that a cold, strong upper current shall impinge upon or blanket the summits of these convectional masses. In the most violent of these late storms this upper current was from the northwest (north 50° west, true azimuth) rather than from west or west-southwest, as usual. Such wind being colder than the usual precipitation wind, the consequence was the formation of hail, which is very rare at sea level in this latitude, and more chain lightning than I have ever seen in any one Hawaiian thunderstorm.

The barometer was very high the first three or four days of February, higher than ever recorded at that date, with violent east-northeast winds, the low area succeeding coming on the 13th and 14th, corresponding to your great storms of the 12th. The anticyclone has returned with March.

NORTH ATLANTIC STORMS.

The paths of the following areas of low pressure and strong winds on the Atlantic Ocean during February, 1894, have been approximately traced on daily charts of simultaneous observations based on data received up to the 28th of March, through the co-operation of the Hydrographic Office, U. S. Navy, and the "New York Herald Weather Service." The western portions of these paths are shown on Chart I.

A. This was a continuation of *F* from the January REVIEW, which was central near the coast of Norway February 1, and in Lapland 2d, after which it disappeared.

B. This was a continuation of *G* from January. It was central February 1, noon, N. 50°, W. 44°; 2d, noon, N. 58°, W. 23°; 3d, noon, about N. 64°, longitude 0°; 4th, noon, N. 62°, E. 28°.

C. This area formed on February 1 off the middle Atlantic coast, and at noon of the 2d was near the southern coast of Newfoundland; 3d, noon, N. 53°, W. 33°; 4th, noon, it had moved northeastward beyond our reports, and was followed by a general rise in the pressure in the North Atlantic.

D. This was a continuation of low area No. I, U. S. series, which was central in Ontario on the 3d; 4th, noon, it was central near Newfoundland; 5th, noon, at N. 50°, W. 43°; 6th, N. 53°, W. 33°, having combined with *E;* 7th, *D* and *E* were lost in the general whirl, whose center was then east of Iceland and near the coast of Norway, in about N. 67°, E. 10°; 8th, it had passed beyond North Cape, and pressure was comparatively high from Great Britain westward to Newfoundland.

E. This was a continuation of low area No. II, U. S. series, which left the coast of North Carolina on the morning of the 4th, and moved eastward until, on the 5th, noon, it was at N. 40°, W. 58°. It moved northeast as a long trough, central on the 6th at N. 50°, W. 40°, after which it joined the preceding area *D.*

F. On the 4th high area No. III, of the U. S. series, moved southeastward over the Gulf States and the Gulf of Mexico; during the 5th and 6th it had extended over the Atlantic States; on the 7th it spread over a large portion of the west Atlantic and adjoined the high area that had prevailed continuously over the east Atlantic near the 40th parallel. During this movement the area of low pressure near Iceland had apparently steadily developed, and extending southward until, on the 10th, noon, the isobar of 29.3 extended from N. 50°, W. 40°, to N. 50°, E. 40°, and the entire region north of this constituted an extensive depression in which a whirl at the western extremity developed on the 10th, and also one at the northeastern extremity, which was soon followed by an entire transformation in the distribution of pressure. The former whirl was, on the 10th, noon, at about N. 50°, W. 30°; 11th, noon, N. 54°, W. 16°; 12th, noon, N. 60°, E. 10°; 13th, noon, N. 60°, E. 30°; 14th, noon, still further eastward, and probably disappeared in the Ural Mountains. During its passage, on the 11th and 12th, north of Scotland destructive gales prevailed over Great Britain.

G. This was a continuation of low area No. V, U. S. series, which was central near Lake Huron at noon of the 10th; 11th, noon, off Cape Breton, N. 45°, W. 59°; 12th, noon, N. 46°, W. 50°; 13th, noon, N. 51°, W. 34°; 14th, ?; 15th, N. 53°, W. 23°; 16th, the center seemed to have moved rapidly northward and dissipated, while the barometer was rapidly rising over Europe and the east Atlantic.

H. This was a continuation of low area No. VII, U. S. series, which developed rapidly on the middle Atlantic coast on the 13th, 14th, and 15th; it was central on the 16th, noon, N. 47°, W. 47°; 17th, 18th, and 19th, it pursued a course north of our reports, but on the latter date it must have been central near Iceland. During these days pressure steadily increased over Europe, with northerly winds, as an area of high pressure advanced southwestward over Sweden, Norway, and Russia. An area of high pressure had prevailed over southwestern Europe throughout the preceding seventeen days of the month, and the fluctuations of this area had depended directly upon its accessions from the adjacent portion of the Atlantic Ocean, while the fluctuations in the latter region

had depended upon accessions from the atmosphere over the West Atlantic and the Western Continent, but on the 15th and 16th the northern side of this European high pressure began to receive an accession from the northward, illustrating the general principle that, although it is easier for the great area of high pressure in Asia to discharge its surplus eastward into Alaska and North America, yet occasions will arise in which a small surplus can flow from it northwestward and thence southwestward into Europe. The overflows northeastward from it into the North American continent exceed in number and intensity those westward into Europe. Simultaneously with this advance of cold northerly winds and high pressure over Norway and northern Europe, which began on the 15th, there occurred the advance eastward and northeastward over Mexico and the south Atlantic States of an area of high pressure which became central north of the Bermudas on the 18th, and on the 19th, N. 40°, W. 45°; 20th, N. 43°, W. 35°, and on the 21st and 22d as a ridge from N. 50°, W. 20°, to N. 30°, W. 60°; from the 17th to the 23d, the Atlantic and European areas of high pressure approached each other slowly and virtually formed one region while, at the same time, a third area of high pressure advanced from the northwest (see U. S. series, high area No. VII) southeastward over the United States, and by the 23d, noon, high pressure prevailed from W. 120° to E. 40°, and between N. 20° and N. 50°. But such an area of unusual high pressure bespeaks an unusual area of low pressure to the northward if not, indeed, also to the southward, and there are corresponding indications of the existence of areas of low pressure on the 19th off Sierra Leone, as also in the equatorial portion of South America.

I. This was a continuation of low area No. VIII, U. S. series, which passed eastward along the northern limit of the United States on the 17th and 18th, and must have been broken up in Baffins Bay on the 19th.

J. On the 19th a trough of low pressure extended from Arkansas to the mouth of the St. Lawrence, and later in the day a depression and cyclonic whirl developed off the middle Atlantic coast; this was central on the 20th, noon, near the Bay of Fundy; 21st, it disappeared north of Nova Scotia.

K. This appears as a well-developed storm center on the 24th, noon, N. 52°, W. 35°, and numerous reports of hurricane winds south and west of that locality are at hand; nothing suggesting the existence of such a storm center had been reported on the 22d or 23d, but low area No. XIV, U. S. series, was in a position to undergo rapid development as it passed over Newfoundland on the 23d; during the 25th this center moved northeastward over the Faroe Islands, and on the 26th, noon, was at about N. 65°, E. 5°; on the 27th, noon, near the Loffoden Islands, and during the 28th it was represented by a new storm center in Finland.

L. The depression or trough, of which *K* represents the eastern end, extended southwestward to N. 55°, W. 40°, on the 25th and 26th, but on the latter date a depression developed (see low area No. XV, U. S. series) on the middle Atlantic coast which moved rapidly northeastward; 27th, it was central at N. 45°, W. 50°; 28th, noon, N. 54°, W. 24°. This rapid motion brought areas *K* and *L* steadily nearer together, and at noon of the 28th the isobar of 29.3 inclosed them both, and extended from N. 50°, W. 30°, to N. 63°, E. 30°; at this time northwestern Europe and the northeast portion of the Atlantic Ocean were included in the general Icelandic whirl and depression, while the west Atlantic and the eastern portion of the Western Continent were under the influence of an area of high pressure, thus very nearly duplicating the meteorological conditions that had existed from the 3d to the 6th, and again on the 24th and 25th.

OCEAN FOG FOR FEBRUARY, 1894.

The limits of fog belts west of the fortieth meridian, as reported by shipmasters, are shown on Chart I by dotted shading. East of the fifty-fifth meridian fog was reported on 10 dates; between the fifty-fifth and sixty-fifth meridians on 4 dates; and west of the sixty-fifth meridian on 7 dates. Compared with the corresponding month of the last six years, the dates of occurrence of fog east of the fifty-fifth meridian numbered 1 less than the average; between the fifty-fifth and sixty-fifth meridians, 1 less than the average; and west of the sixty-fifth meridian, 2 more than the average.

OCEAN ICE IN FEBRUARY, 1894.

The following table shows the southern and eastern limits of the region within which icebergs or field ice were reported for February during the last 12 years:

Southern limit.			Eastern limit.		
Month.	Lat. N.	Long. W.	Month.	Lat. N.	Long. W.
	° ′	° ′		° ′	° ′
February, 1883	42 01	52 46	February, 1883	46 10	45 44
February, 1884	42 00	50 00	February, 1884	46 50	43 45
February, 1885	41 50	51 12	February, 1885	47 52	42 00
February, 1886	46 10	47 15	February, 1886	48 00	44 47
February, 1887	40 00	48 00	February, 1887	46 26	41 50
February, 1888	44 59	45 08	February, 1888	44 59	45 08
February, 1889	45 35	48 00	February, 1889	45 35	48 00
February, 1890	41 12	50 12	February, 1890	44 30	35 30
February, 1891	44 20	48 00	February, 1891	44 33	44 59
February, 1892	47 25	47 55	February, 1892	49 05	46 30
February, 1893	45 11	48 50	February, 1893	46 20	46 40
February, 1894	44 28	48 50	February, 1894	47 30	44 40
Mean	43 44	48 50	Mean	46 29	44 22

The region in which Arctic ice was reported for the current month is shown on Chart I by crosses. The southernmost ice reported, a large berg, noted on the 25th, was about three-fourths of a degree north of the average southern limit, and the easternmost ice noted, a large berg, observed on the 28th in the position given in the table, was about one-half of a degree west of the average eastern limit of ice for February.

Icebergs were reported on the 8th, 10th, 12th, 13th, 17th, 18th, 20th, 23d, 24th, 25th, and 28th. Field ice in large quantities was noted near Cape Breton Island on the 4th and 13th. Field ice was also encountered on the 7th to 10th, 12th, 17th, 18th, 24th, and 28th. A report of the British steamship *Barcelona* states: "About 300 miles off the coast of Newfoundland passed through large quantities of field ice extending to within a few miles of St. Johns." (Date unknown.)

No icebergs were reported during the month of February, 1894. On the 13th and 20th field ice was encountered off the southeast coast of Newfoundland. On the 15th, 17th to 25th, and 27th field ice was reported along the eastern edge of the Grand Banks, north of the forty-fifth parallel.

TEMPERATURE OF THE AIR.

[*In degrees Fahrenheit.*]

The distribution of the monthly mean temperature of the air over the United States and Canada is shown by the dotted isotherms on Chart II; the lines are drawn over the high irregular surface of the Rocky Mountain plateau, although the temperatures have not been reduced to sea level, and the isotherms, therefore, relate to the average surface of the